Space Weather Technical Forecast

Issued on Monday, 29 May 2023 at 01:26 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: R1/R2 radio blackouts likely at times throughout. Active electron fluence likely Days 3-4.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate with one M1.0 flare observed from AR3315 at 28/1036 UTC. Otherwise, there have been frequent C-class flares observed, mostly from AR3311 and AR3314 in the northwest. There are currently 9 regions on the visible disc. AR3315 (Ekc/Beta-Gamma-Delta) is by far the largest region on the disc and is magnetically complex, containing one small and marginal delta spot. AR3314 (Dai/Beta-Delta) in the northwest also contains a delta spot but is significantly smaller. AR3311 (Eso/Beta-Gamma) is also a region of note being in beta-gamma formation but it is rather long and open and continues to decay. All other regions on the disc are either small or simple. No Earth-directed CMEs were observed during the period.

Solar Wind / Geomagnetic Activity: Solar winds observed at L1 have remained at slightly elevated levels between 400 and 480 km/s. Density has been below average (<5 ppcc). The total interplanetary magnetic field strength has been weak and largely steady around 5-6nT. The north-south component was predominantly negative until 28/1230 UTC, and has since weakly fluctuated between +5/-5. The phi angle was mostly negative (towards the Sun), with brief positive (away from the Sun) spells. Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV at GOES-16) has remained at background levels throughout. High energy electron flux (greater than 2MeV at GOES-16) was initially at mainly high levels, peaking at 2160 pfu at 28/0535 UTC, but dropped to background levels around 28/0600 UTC. The associated 24 hour fluence was Active (above 1e8 integrated pfu) but has begun to decline from a peak of 2.65e8 integrated pfu at 28/0000 UTC, falling below Active by 28/1800 UTC. Electron fluence observed at 29/0000UTC was 2.32e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to remain Low or Moderate, with the main risk of significant flare activity from AR3315. There is a slight chance of X-class flaring throughout.

Solar Wind / Geomagnetic Activity: A weak CME that left the Sun on 25 May may give a glancing blow at Earth on Day 1 (29 May). A second CME from an eruption on 26 May could give a glancing blow at Earth late on the Day 2 (30 May) or on Day 3 (31 May). However, both are likely to pass Earth without effect. Solar winds are likely to remain largely at slightly elevated levels due to CH HSSs. Geomagnetic activity is expected to be mainly Quiet to Unsettled, but with a risk of Active or G1/Minor Storms Days 1-3 due to potential CME impacts.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at background levels. There is a slight chance of reaching the S1/Minor Storm threshold should any larger flares occur, mainly from AR3315. High energy electron flux (greater than 2MeV) is expected to have a diurnal cycle to high levels through the period. The forecast CME arrivals and high speed stream connections could generate enough geomagnetic

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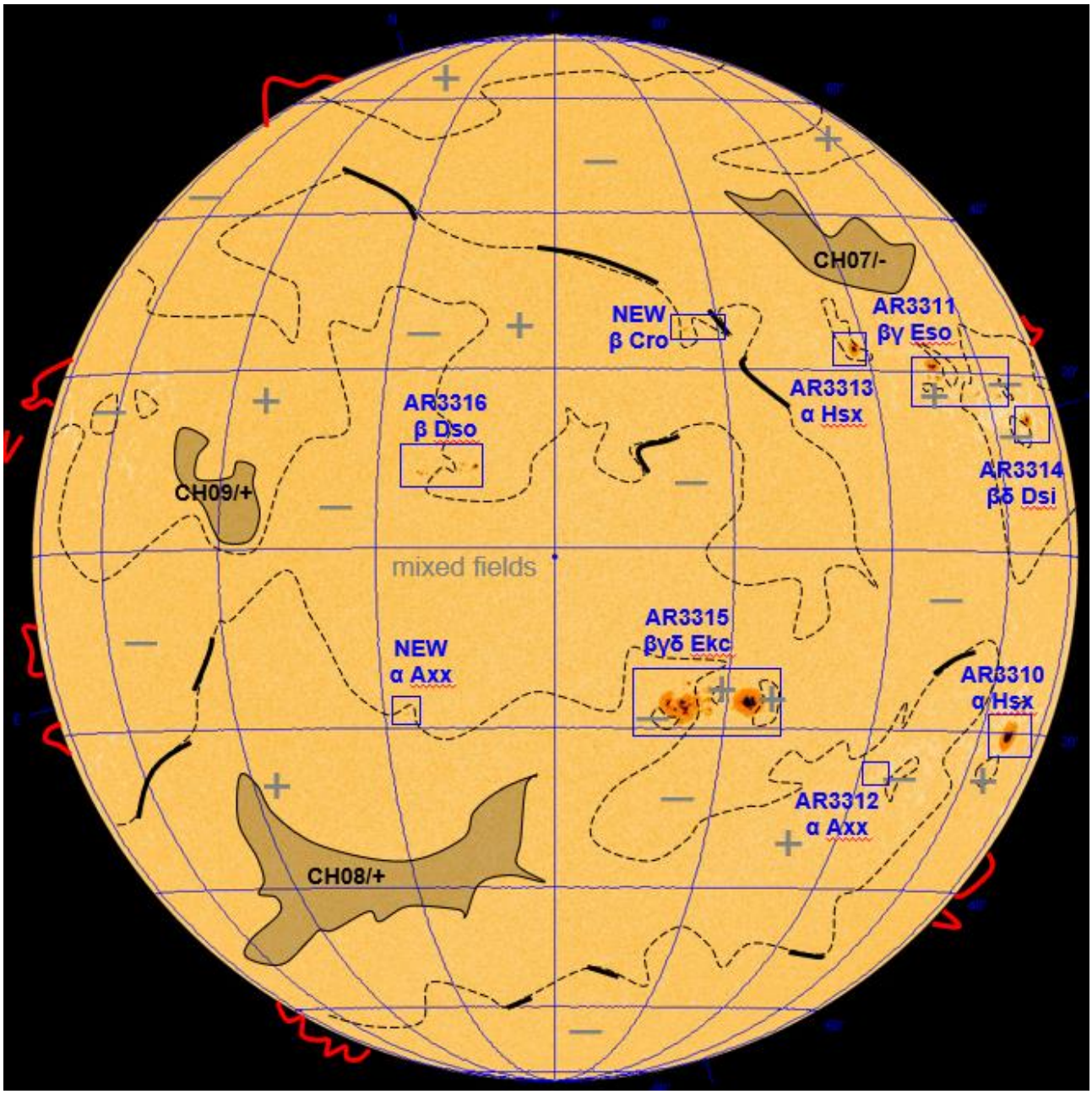
activity reduce electron counts Days 1-3 (29-31 May), but with limited confidence. Electron fluence values are expected to return to above the Active (1e8 integrated pfu) threshold by Day 3, but there is low confidence later in the period due to the uncertainty of modifying factors.

Figure 1. Solar Analysis Valid 28/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth-directed CMEs have been observed in the past 24-hours. However, a number of Enlil ensemble members support the arrival of a weak CME that left the Sun on 25 May giving a glancing blow at Earth on Day 1 (29 May). A second CME from an eruption on 26 May could give a glancing blow at Earth late on the Day 2 (30 May) or on Day 3 (31 May), although much of this second feature is directed southward.

Solar winds are likely to initially remain slightly elevated but close to ambient levels due to the slight but waning enhancement from a recent HSS. Persistence would suggest that the high speed stream from CH07/- is likely to connect on Day 1, following the pattern of the previous rotation. CH07/- is of a similar shape and size to the last rotation, which would support this aspect of the forecast and suggests peak speeds of around 500km/s. On Day 3, solar winds are likely to return to ambient levels as this enhancement fades.

Mainly Quiet geomagnetic activity is forecast, with occasional Unsettled intervals. There is a slight chance of Active or G1/Minor Storms on Days 1-3 (29-31 May) due to the possibility of glancing impacts from the aforementioned CMEs. There is also a very slight chance of CIR effects ahead of the HSS connecting on Day 1, however, this was not observed on the previous rotation and no signal has been observed at STEREO-A.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	20	10	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

No Earth-directed CMEs currently expected, however, see text above for more detail.

Figure 2: MOSWOC SWPM showing forecast solar wind speeds

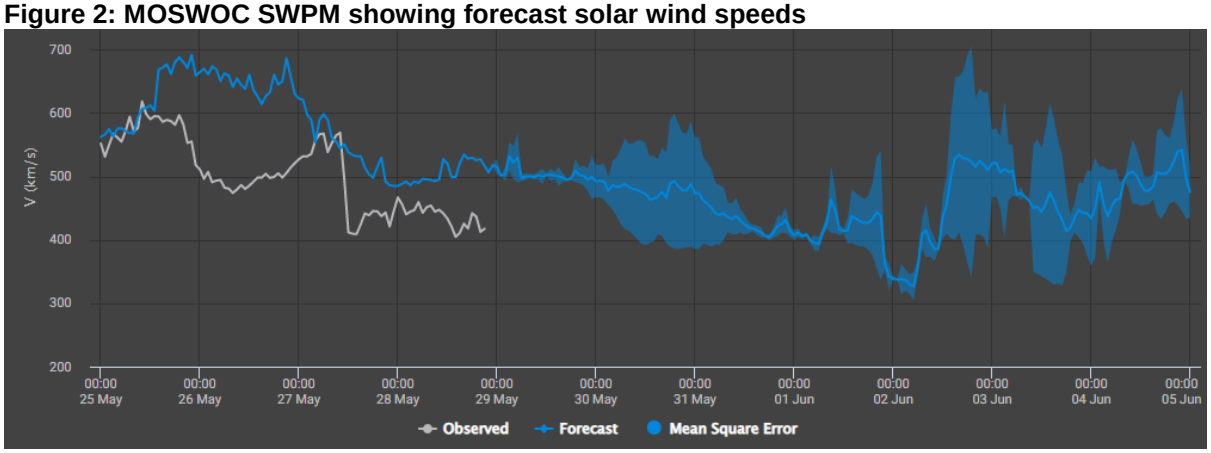

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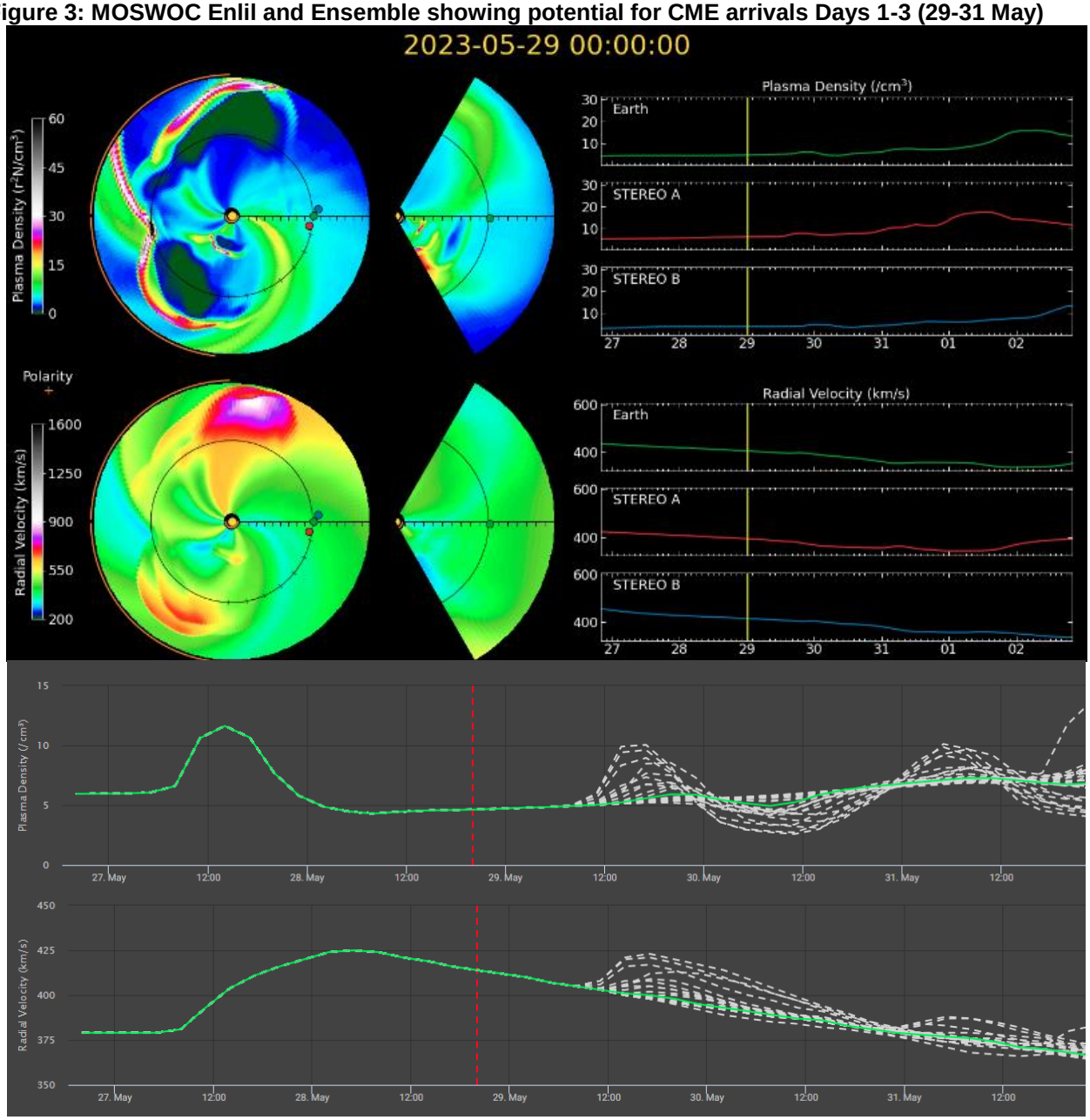
Figure 3: MOSWOC Enlil and Ensemble showing potential for CME arrivals Days 1-3 (29-31 May)



Radio Blackouts - X-Ray Flares:

Solar activity has been Moderate over the past 24 hours, with a single M1 flare observed at 28/1036 UTC. Further isolated M-class flares are considered likely through the forecast period, mainly due to a number of complex regions in the western hemisphere; AR3311 (Eso/Beta-Gamma), AR3314 (Dsi/Beta-Delta) and AR3315 (Ekc/Beta-Gamma-Delta), and there is a slight chance of an X-flare. AR3315 is particularly large and contains a marginal delta spot region. There are presently 6 other regions on the visible disc, but currently these are either small or simple.

Several regions, some of which may have been responsible for significant activity as they tracked across the farside, are due to rotate onto the eastern limb over the next few days and are expected to lead to an increase in solar activity.

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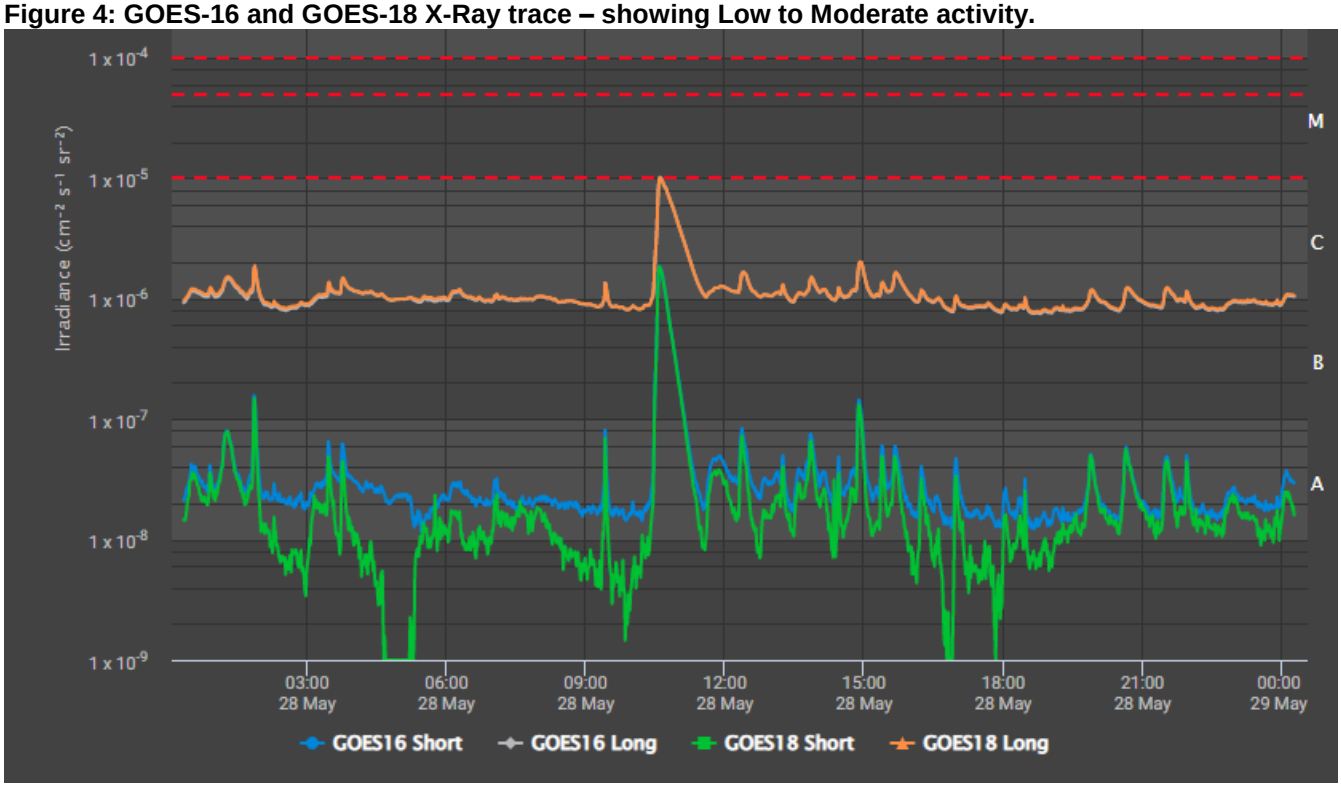
X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	60	60	70
Very Active	R3 to R5 X Class	No	15	15	15	15

Figure 4: GOES-16 and GOES-18 X-Ray trace – showing Low to Moderate activity.



Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, as observed by GOES16, is at background levels. There is a slight chance of S1/Minor Radiation Storming, should any larger flares occur, with AR3315 the most likely source region as it transits the western hemisphere.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	20	20	20	20
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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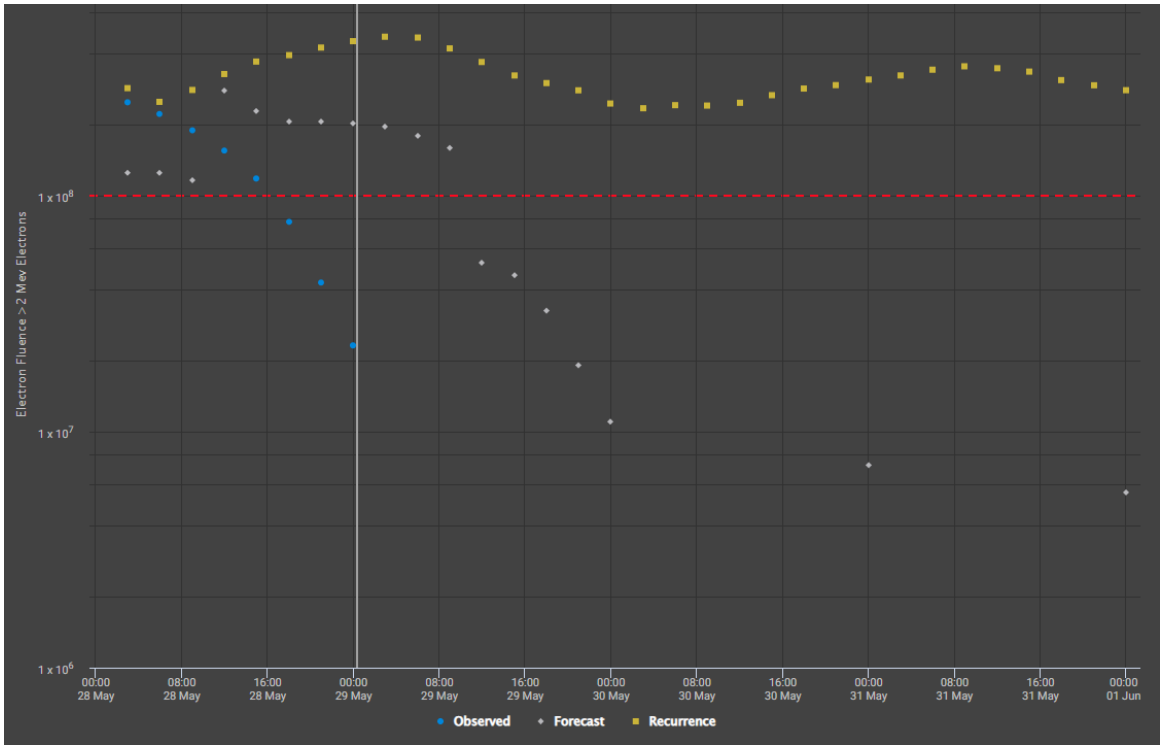
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) has been at high levels and is likely to return to such levels during diurnal peaks in the absence of any high confidence modifying factors, particularly later in the forecast. The most likely source of any geomagnetic activity is from two CMEs on Day 1 (29 May) and Days 2-3 (30-31 May), although both these are only likely to glance the Earth at most, resulting in limited geomagnetic activity.

Associated 24 hour fluence is likely to recover to above Active (1e8 integrated pfu) by Day 3. Low confidence in the forecast, with REFM showing a large spread in possible fluence values. The increase in probabilities later in the forecast reflects the uncertainty with geomagnetic activity and the charging and relaxing of electron belts during the period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	40	40	60	70
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: GOES-16 Electron Fluence and forecast REFM.



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